Notes by Alexander Graham Bell, October 16, 1901

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1901, October 16, Wednesday At B.B.

A whole lot of thoughts and experiments have not been noted Will try to save what I can.

It is well known that the center of pressure of an aeroplane is in front of the center of form, so that if we divide an aeroplane in imagination into two halves— a front half and a rear half — the pressure on the front half exceeds that on the rear half. From which it follows that the total pressure should be greater if the aeroplane were to be cut in half longitudinally, and the two halves separated so as each to be acted on by fresh air

Fig 1

Fig 2

For example, the pressure on (b) Figure I, is less than o (a) Figure I, but if separated as in Figure 2, there is no reason why (b) should not experience the same pressure as (a). Hence the total pressure experienced by (a) and (b) separated, as in Figure 2, should be greater than that experienced by them when united as in Figure I.

This principle is well known, but I do not know that it has been carried out to its logical conclusion, Viz: — 400 that the aeroplanes should be as narrow as possible.

Given an aeroplane of a certain length, say 1 meter, and a certain width, say 1 meter, we have a total surface of 1 sq. meter exposed to the wind. Now we know that the total pressure received by this surface will be greater if it is divided into two aeroplanes, each of 50 cm in width, separated by a space. We may also anticipate that a still greater pressure would be experienced by dividing it into four aeroplanes 25 cm. each in width. Still greater by dividing it into 10 aeroplanes of 10 cm. each in width, &c., &c.

How narrow could the aeroplanes be made successfully? If the surface were divided into a multitude of aeroplanes only 1 cm. wide, would we have a still greater increase in pressure. In such a case the aeroplanes would have the width of ordinary tape.

We tried the experiment of making a kite with tape aeroplanes. This kite is shown in the photograph on p. 398 which seems to have been taken on October 11. The kite framework is 100 cm. long. The equilateral triangular cells of 50 cm. each side. The aeroplane surfaces are formed by a long piece of black tape about 1 cm. wide, wound spirally around the whole framework, so that the spaces between adjoining aeroplanes are greater than the width of the aeroplanes themselves. My recollection is that the aeroplanes are 1 cm. wide, and the spaces between 2 cm. This kite was tried on Wednesday, October 9, before it was completed. The amount of tape on hand was only sufficient to cover about 401 two-thirds of the length of the kite. We attached the kite, however, to the bamboo pole on Wednesday afternoon (October 9), to let Mabel see the effect. There was only a slight breeze blowing at the time, but the pull exerted by the kite was something greater than we had ever before experienced with a kite of these dimensions, even in a stiff breeze

I find this experiment was noted at the time in the Laboratory Note Book, p. 102, under date 1901, Oct. 9, Wed. The tape kite was completed Thursday, October 10, and the photograph shown on p. 398, was taken October 11.

We have not yet attempted to fly this kite excepting from the bamboo rod. It does not seem to fly well, its chief peculiarity being the tremendous pull that it exerts. The tape aeroplanes are too long in proportion to their width. They are 50 times as long as they are wide: Result, the surfaces of the different aeroplanes do not remain parallel with one another under the action of the wind. The tape twists in 402 different directions at different places, so that, when the keel of the kite is horizontal, the aeroplanes do not keep their edges to the wind, but turn in different directions so as to catch the wind. This accounts for the tremendous pull.

PULL however, can be translated into SUPPORTING POWER. The kite that pulls the most, if held at a great angle to the wind, will support the most, if horizontal to the wind. The pull represents a resistance to motion through the air, and if this resistance is so arranged as to retard descent, it represents that important element supporting power.

The twisting of the tape aeroplanes caused them to expose a different surface to the wind at different times. If presented edgeways to the wind, the resistance of each tape would be small, but a little angular deviation would make the resistance large.

This suggested the thought that strings or threads might be used in place of tape with advantage, even though the length of each string should be enormous in comparison with its width . The strings being cylindrical in shape would not offer a varying surface to the wind. Mr. Ferguson has almost completed a kite wound round with twine instead of tape:— The space between each layer of twine being greater than the diameter of the twine.

Experiments in the Laboratory have been delayed for some days past because Mr. Ferguson has been at work on the top of the mountain helping John McKillop get his sheep weighing apparatus in order, and he has been absent on Monday and Tuesday 403 on account of sickness. He only returned this morning and is now completing the string kite.

We may foresee one difficulty with the string kite, as with the tape kite, resulting from the great length of each string in comparison with its width: — The string surfaces will not remain parallel with one another under the action of the wind. They will act like the strings of a musical instrument, and will vibrate at different rates according to their tension.

Thought : — Damp their vibrations by strings woven in at right angles.

Thought : — Use a stretched net.

Thought : — A piece of muslin, or woven material, with pores larger than the diameter of the threads composing the material, should preserve its surface under the action of the wind.

Thought: — If the aeroplane principle described above is correct, one logical consequence would be that porous cloth, like muslin, mosquitoe netting, &c., should do better than air tight cloth — this is opposed to all our ideas of kite surfaces. Every attempt has been made to secure cloth that the air will not pass through . If the narrow aeroplane idea is correct porosity will prove an advantage.

EGRO: — Try muslin and mosquitoe netting in a kite. And this reminds me, that we have never tried a kite completely covered with cloth, excepting the experiment that was made some years ago — successfully by the by — to use a long 404 pipe of triangular cross-section as a kite. We have photographs of what we called “Washington's monument” in the air. I remember it would not fly with the ends closed, but with the ends open, and the air passing freely through the pipe it flew well.

Mr. Ferguson has covered one of our kite frameworks 100 x 50 cm. with cloth, so that we may try the experiment.

Here is an interesting thought: — If the narrow aeroplane idea is correct, then we want a multitude of narrow surfaces with spaces between — porous material, muslin, mosquitoe netting, &c.: — But, if it is not correct then we want a kite framework completely covered with cloth, and not with separated cells at all.

Poro sity , or non-por osity — that is a question which can easily be settled by experiment.

When our kites break loose they generally settle down gently with an oscilating motion. They fall for a short distance with the bow depressed, moving down , then they go backwards a short distance stern forwards, until by successive oscilations of this sort they reach the ground. This would hardly be a safe method of descent in a flying machine, ot in a kite carrying a man. The thought occurred that if the aeroplanes consisted of narrow strips of cloth having their front edges tacked on to wooden sticks, with their back edges free, that the sagging of the cloth at the rear would cause the kite always to move forward horizontally 405 when descending

Given headway, and you can steer. A man in a kite could control the alighting of the kite if he had headway, so as to steer up at a considerable angle when close to the ground. We converted one of our small kites into a kite with narrow aeroplanes, as shown above, retaining the rear cell untouched as a rudder.

On Wednesday, October 9, we flew this kite in the light breeze then blowing, and out the string. The kite in descending acquired considerable headway, and made straight tracks for me, like an arrow from a bow. I succeeded in dodging it and it whizzed by right over my head, within six inches, I should say. Mabel was present upon the occasion.

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The rear cell was then cut away, so as to make four narrow cells, as shown in photograph on p. 395, (First photograph), which was taken on October 9. The second photograph on that page shows the kite flying from the bamboo pole. Another picture of this kite is shown in the second photograph on p. 397, taken October 11.

On October 9 we fitted on to a kite framework two cells of aluminun 10 cm. wide each. Picture of this kite shown on p. 396, taken October 9. The second and third photographs on that same page (p. 396) show the aluminum kite flying from the bamboo pole.

In the first photograph on p. 395 the aluminum kite can also be seen in the background trying to fly from the bamboo pole. This kite has since been fitted with three aluminum cells, see first photograph on p. 397, taken October 11. This has not yet been tried.

If we construct kites of a large size of thin wood or steel wires — compound kites — it becomes a serious problem how to land them successfully without injury to the kite. One way that has occurred to me is to use a net sustained by poles, and land the kite in the net. Some ideas are shown the Laboratory Note Book, p. 93, under date Friday, October 4, 1901. We have purchased a fishing net to be used in landing the next large kite made.

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The most important point reached yet has been the success of the compound Hexagonal kite shown on p. 371, photograph taken October 4. Successful experiments were made with it same day (October 4), see pp. 369–370. The important point has been proved that a large kite compounded of several smaller triangular kites can be made to fly as well as the component kites, and with no greater ratio of weight to surface. The whole compound structure, too, being solid and well braced in every part.

I have been considering for some time past the best form to give to a large kite, for I propose to make at least one giant before returning to the States. Various ideas have been copied from my home note book, by Miss Safford, on pp. 374 to 381 from sketches dated by me September 30. Other ideas appear in a new volume of Home Notes, on pp. 31, 32, 33, 34, dated Sunday, October 6, 1901, and in the same volume pp. 59 and 60, dated October 15, 1901. Other thoughts are noted in the laboratory note book pp. 92 and 93, dated Friday October 4, 1901, also Laboratory Notes pp. 95, 96, and 97, dated October 4.

I am most struck with the idea shown in the Laboratory Note Book, p. 97, dated October 4, upper diagram. In which a good substantial core appears, of triangular form, surrounded by the lighter kite framework. The substantial c enter part, well braced, and perhaps brought to a point at either end, a la Santos Dumont's framework, would afford a substnatial support for men or machinery, and the center of gravity would 408 be very nearly in the center of the kite. I am satisfied that the load carried by a kite should be very little below the center of form. When we attach a metal rod to the keel of a triangular kite the kite has a tendency to oscilate like a pendulum. The weight should be nearly in the center of the triangular cell, but a little below it

Central core surrounded by a cellular kite — structure composed of triangular cells (not shown)

,Such a structure, if made of wood or metal wires would not be adapted to float on the water, and therefore would have to be used on land, and means provided for safely landing it in a net.

If a cellular kite should be developed into a flying machine, with engines, &c. on board, the landing of such a machine would not present great difficulties. The machine 409 could simply be a shored, and would then fly as a kite if there is any breese. Without a breese, or with an unsufficient breese the tethered machine could be kept up by the action of its own propellers. Special landing places could be provided consisting of nets stretched between poles. These should be portable, and could be easily used in warfare upon the field

Bringing down a giant Kite

The triangular form, if flown keel downwards, has special advantages for use in warfare because it would be difficult for an enemy to injure the kite by firing at it. Bullets would pass easily through the supporting surfaces without injuring them materially for flying purposes. The resistance they would oppose — as the surfaces would in nearly every case be at a considerable angle to the line of impact — would tend to deflect the bullets, so that it 410 would be very difficutl, for the bullet to reach the central core containing the man, if it had to pass through first several thicknesses of resisting material presented obliquely with air spaces between. Quite independently of this the man in the central core could be almost completely protected by a V-shaped metallic shield placed underneath. Bullets fired from below would reach this shield with impaired force on account of gravitation, and be deflected instead of penetrating

A man firing a rifle at the man in the kite protected by the V shaped metallic screen. Picture shows the deflection of the bullets. AGB

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Quite independently of any flying machine carrying a motor, a mere kite, of the above construction, carrying a man, would have a great advantage in warfare over a captive balloon. The captive balloon must be kept at a great distance away from the enemy, because, if a single bullet penetrates, the gas comes out and the balloon falls.

But,, the balloon is so conspicuous an object, that the moment it appears it becomes a target for the enemy, and the bullets that do not hit the balloon, fall in the ranks of the army, whose position is located to the enemy by the position is located to the enemy by the position of the balloon. Great mortality is found from this cause in the military escort of the balloon. The enemy can always locate them, however concealed by trees, &c., and they get the benefit of the bullets aimed at the balloon.

A kite, however, may be made to fly by the to or more wires directly over the enemy, and if the man is protected by a metallic V-shaped shield below him, it need not be at any very great elevation. The man can telephone informa tion through the conducting wires, besides being able to do damage from above. The kite may be shot through in a hundred places without bringing it down or materially injuring its flying properties, and if the man in the kite is directly over the enemy, the bullets fired at the kite — though they may reach the altitude of the kite with diminished velocity — return with full force upon the enemy themselves.

While, therefore, a balloon raised at the rear of an attacking force would very properly be a target for the enemy, they would be chary at firing at a kite directly overhead 412 where their bullets would return on their own heads. If it was a balloon overhead they might take the risk because one shot suitably placed would bring the balloon down. But they would surely think twice before firing at a kite that could not be brought down by a whole volley even though shot through in numerous places.

The light kite framework would be an advantage in this, that it might be injured in one place and not in others. It would also be of advantage in this respect, that the light kite structure would cause the kite to descend slowly, if any accident happened, and upon reaching the ground the light structure below the central core would be crushed in like an egg-shell thus reducing the shock to the man in the central core.

Such a kite should be flown by two or more wires. Should the enemy succeed in breaking one of these wires, it would still be held by the other, and go off to one side. Should the supporting surfaces be fixed to the solid framework in their front part, and be loose at the rear, the kite would gather headway in descending, and the man in the kite would then have the power to steer the kite to a suitable landing place, and reduce the shock of descent by steering upwards at the critical moment of landing.

Of course, should the kite carry up an engine and propeller, as well as a man, it would in reality be a flying machine, and be independent of any wires connecting it with headquarters. In this case, of course, we should lose the advantage of telephonic communication. Either in the case of the 413 kite or flying machine, the apparatus on returning to its proper quarters could be landed safely without injury upon a not stretched between poles.

While the triangular form seems specially adapted for use in warfare, the hexagonal form, see this volume p. 371, has the advantage, I think, in point of solidity of construction. The cloth forming the outer surface of a hexagonal compound cell cellular kite ties the whole structure together, so that it is practically rigid. A hexagonal kite of giant construction could easily be built with a hexagonal cor e — or even a triangular cor e — I am uncertain at the present time which form to adopt in the giant kite I am now planning. Int?

In the meantime we have taken to pieces the hexagonal kite shown on p. 371, for the purpose of using the component kites in experiments to settle the best form of covering. The form we decide upon — tape — narrow strips of cloth — wide strips of cloth — aluminum, &c., &c., — will be used utilized in the large kite.

We will make our large kite of wood, because Mr. Ferguson is a carpenter and can handle a kite of this description much more readily than one of metal; but I would propose in a practical kite for war purposes, that the interior core should be made of metal tubing, and the light kite structure surrounding it of metallic wires, forming a sort of basket work. I have satisfied myself by measuring and weighing wires of steel and brass, that a structure of this kind can be made 414 as strong, or stronger, than if made of wood, without weighing any more — probably weighing less.

I have not yet satisfied myself that the supporting surfaces could also be made of metal, but I am inclined to think that thin brass or copper foil could be used, or even tin, for the wing surfaces, in which case the metallic surfaces could be soldered to a the metallic framework and add immensely to the solidity of the whole structure.

We could certainly use aluminum, but there are difficulties in the way of attaching it to the framework, as we cannot solder it. After all, it may be an advantage to use for the wing surfaces fragile material easily penetrated by bullets.

I have not yet weighed strips of leather, but I am inclined to think that leather surfaces underneath that part of the core where the man and his shield are located, would prove to be a material defence to the man. It would surely be extremely difficult for a bullet traveling even at a very high velocity, to penetrate several layers of leather, with air spaces between, if the leather surfaces are presented obliquely to the line of advance of the bullet? In such a case few bullets could possibly reach the V-shaped steel shield, and those that did would be so reduced in velocity and so turned from their original path, that they would surely, in almost every case, glance off without penetrating.

Mr. Ferguson is now making a series of wooden frames like the following 415 after the manner of the folding kite, see pp. 276, 277, 278, 279. A large number of frames will be made, which can be tied together to form a compound kite of triangular hexagonal, or any other desired shape, and thus guide us to the best form for the proposed GIANT. In the meantime I am going on with my calculations relating to a giant structure.

On Saturday, October 12 rowed up from the warehouse to the point with Daisy, Bessie MacRae, and Miss Safford. Saturday evening telegram received from Mabel announcing her safe arrival in Washington, and asking me what I thought of Santos Dumont's latest achievements. This part of the telegram was unintelligible until last night when we received the New York papers of Friday, Saturday and Sunday, containing accounts of another attempt by Santos Dumont to win the Deutsch prize. His experiments with the new dirigible balloon seem to have been wonderfully successful, but unfortunately he failed to win the prize owing to another breakdown. Al the world hopes he will get it. He certainly, if any man, deserves success.

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Sunday, October 13, Daisy, Miss Safford and Bessie MacRae walked down to the House Boat in the afternoon and took lunch there. Bessie MacRae returned to Baddeck Monday morning, October 14.

Monday, October 14, George McCurdy and I went up the mountain to see the new sheep weighing machine, which works well. We did not put any looking glasses inside the weighing box, but put in a good supply of oats. The sheep on entering he the box immediately discovered this fact and remained perfectly quiet while being weighed. The spring balance is so great an improvement and reduces so materially the labor involved that I have decided to weigh the sheep daily for at least a month, whatever use we make of the weights the records will surely be of value some day, and out of the multitude of records we will get reliable facts. Susie McCurdy came to dinner Monday, October 14, and went home this morning. She is going to Halifax Friday the 18th with Miss Lina McCurdy to try and see the Duke and Dutchess of York. Received note from Mabel, Monday, October 14 written on the train in Maine near Waterville.

Yesterday, Tuesday October 15 — a blank — HEADACHE. In the evening Mr. McInnis called to see me and made a confidential communication which I wrote about to Mabel last night. Today, Wednesday October 16 have devoted the whole day to this dictation.

A.G.B.